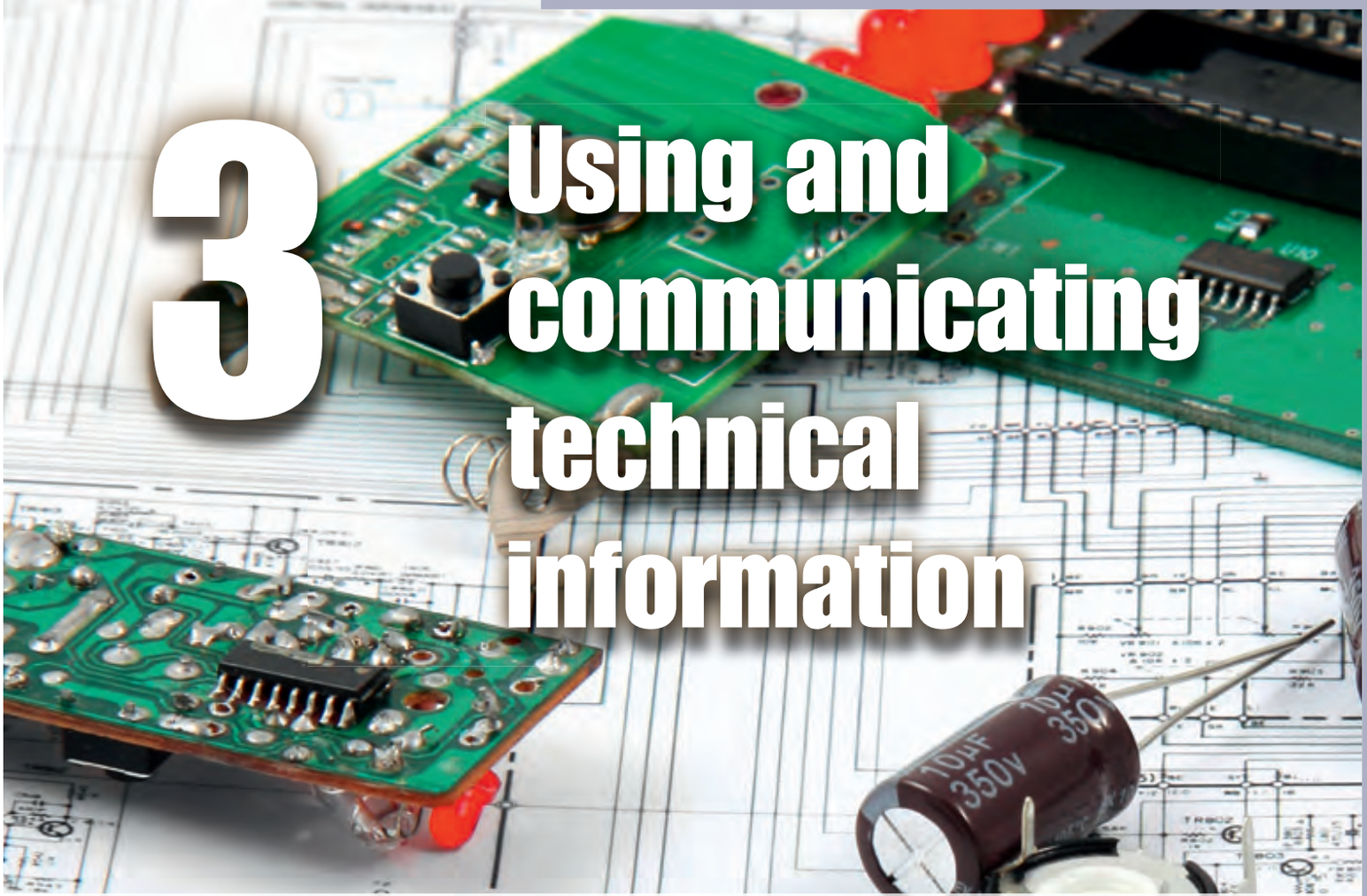

3 Using and communicating technical information

Being able to use and communicate technical information is an important engineering skill. It is a skill you need to learn at the earliest stage of your engineering career. This chapter will help you to make sense of the information you need to do your job. It will show you how information is presented and how to make the best use of it.

You can communicate in many different ways – drawings, instruction manuals, even how you work with others in meetings. In this chapter you will learn how to make good use of information. This means making sure that you have all of the necessary information, and checking it is accurate and up to date before using it.

In this chapter you will learn about:

- communicating engineering information
- information needed to do the job
- written documentation
- specifications
- drawings and diagrams
- care and control of documents and drawings

M03_PEO_SB1_5088_M03.indd 49 27/07/2012 12:48

Case Study

In Formula 1 racing every second counts! The success of a Formula 1 racing team not only depends on every team member doing their job to the highest standard but also providing the best possible support for the rest of the team. Everyone needs to work together all of the time, from the mechanics and technical specialists to the race engineer and the driver.

The race engineer's main role is to get the best from the car and the driver at the circuit. However, this is not their only job. They have to communicate with the data analyst and mechanics, decide what changes to make and co-ordinate these changes. Away from the circuits they must analyse the data from previous track times. They also have to get the cars ready for the next circuit and make sure that everyone is updated. Race engineers need very good communication skills – without these skills there's very little chance of winning a race.

Figure 3.01 A Formula 1 racing team

Hands On

1. List three essential skills needed by a race engineer working in the motorsport sector.
2. Use the Internet to find out about the job of a motorsport design engineer. How does this job compare with that of a race engineer?

Key terms

Verbal communication – speaking and listening

Body language – gestures, facial expressions and body posture

Written communication – memos, notes, letters, reports, email and text messages

Graphical communications – charts, sketches, diagrams and drawings

Communicating engineering information

In your everyday life you communicate with other people in many different ways. The race engineer might talk to someone face to face or on the phone if they are far away. This is **verbal communication**.

They might use **body language**, for example gestures, facial expressions and body posture. In some cases **written communication**, such as text messages, email, notes or letters might be a better way of getting the message across. In other situations, **graphical communications** such as sketches or drawings might be more effective.

M03_PEO_SB1_5088_M03.indd 50 27/07/2012 12:48

You might not work as a race engineer. But whatever role you have, it is important to know how to get hold of the information you need to do your job properly.

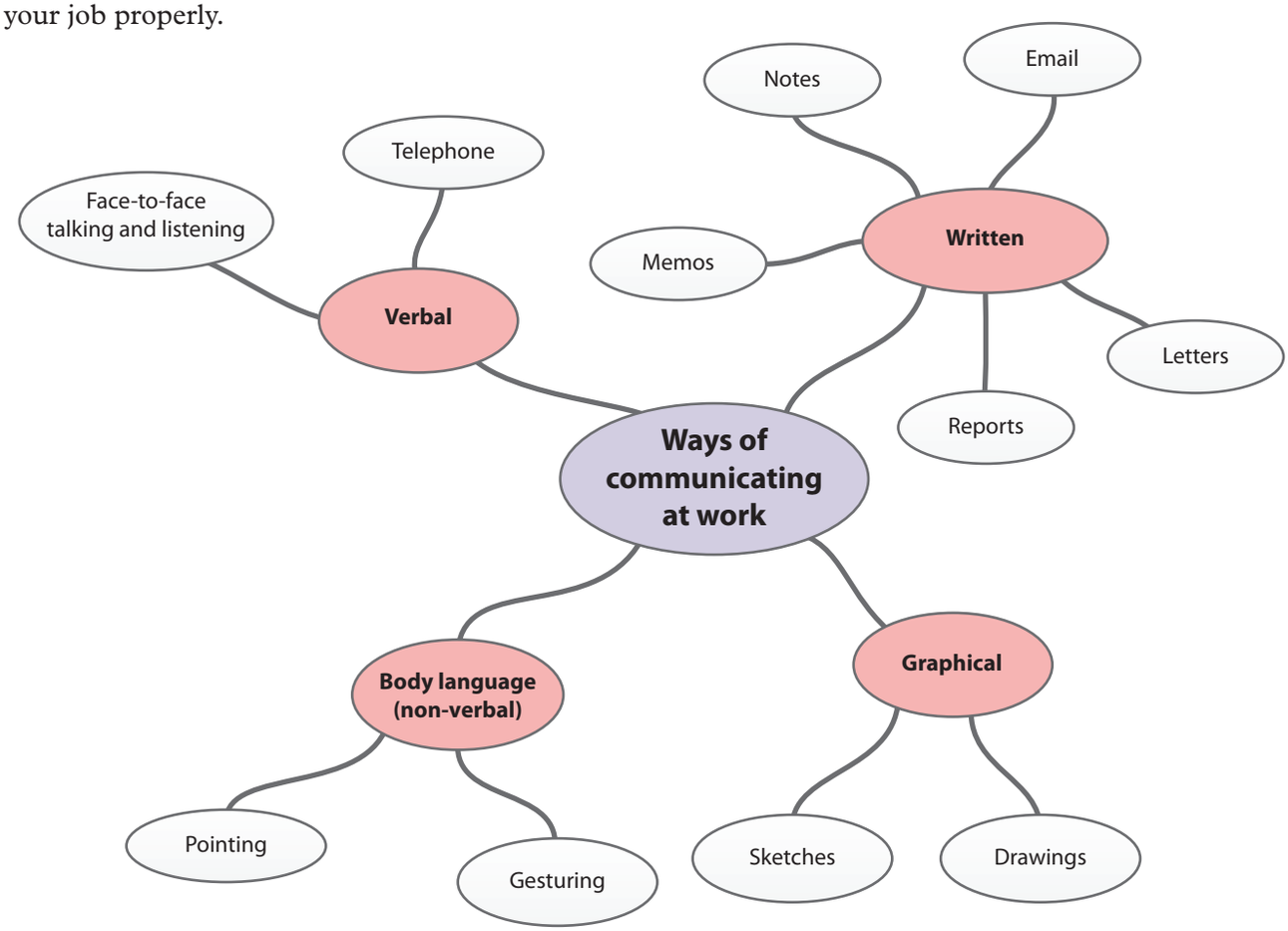

Figure 3.02 Ways of communicating at work

Hands On

Working with two or three other students, decide which method of communication you would use in each of the following situations and why.

1. Advertising the sale of your car.
2. Explaining the fire drill to a group of visitors.
3. Giving directions to a stranger who needs to find the nearest railway station.
4. Describing the way in which a sheet of metal can be cut into a number of smaller pieces.

Information needed to do the job

For many engineering tasks you need information to be written down. This text is usually accompanied by charts, graphs, tables, diagrams and/or drawings. Information needs to be presented in a clear, accurate and up-to-date way. It needs to be set out in a way that makes it is impossible to misunderstand.

M03_PEO_SB1_5088_M03.indd 51 27/07/2012 12:48

Key terms

Dimensions – precise measurements of width, height, depth and radius

Precision – the closeness to the correct value. When a task is being carried out to a high degree of precision any difference from the correct value is very small

Accuracy – how exact a value (e.g. a dimension) is. When a measurement is accurate it is very close (or the same as) the correct value

Tolerance – the difference between the measured value and the correct value. Tolerance is often expressed as a range of values or a percentage of the correct value

Finish – one or more processes that are applied to a product in order to improve its appearance or to protect it from corrosion or abrasion

Where measurements or **dimensions** are used these need to be clearly written – both the number and the correct unit. Where measurements are critical, for example where **precision** work is being carried out, the required **accuracy** and **tolerance** should also be specified.

For example, if you had to produce a case for a small item of electrical equipment, as an absolute minimum you would need the:

- dimensions of the case
- material the case is to be made from
- **finish** to be applied to the case
- dimensions of any holes, apertures or fixings.

As an example, the information needed to construct an equipment case for a particular application might be as follows:

Dimensions:	height 95 mm, width 350 mm, depth 270 mm
Material:	mild steel thickness 1.2 mm
Finish:	paint, light grey RAL 7035
Fixings:	M4 captive nuts (4), M4 ×12.7 mm screws (4)

This information is useful but it is still not enough to actually manufacture the enclosure! To be able to make it, you would need a drawing like the one shown in Figure 3.03. This drawing shows the dimensions of the equipment case and a very clear idea of how it will be made.

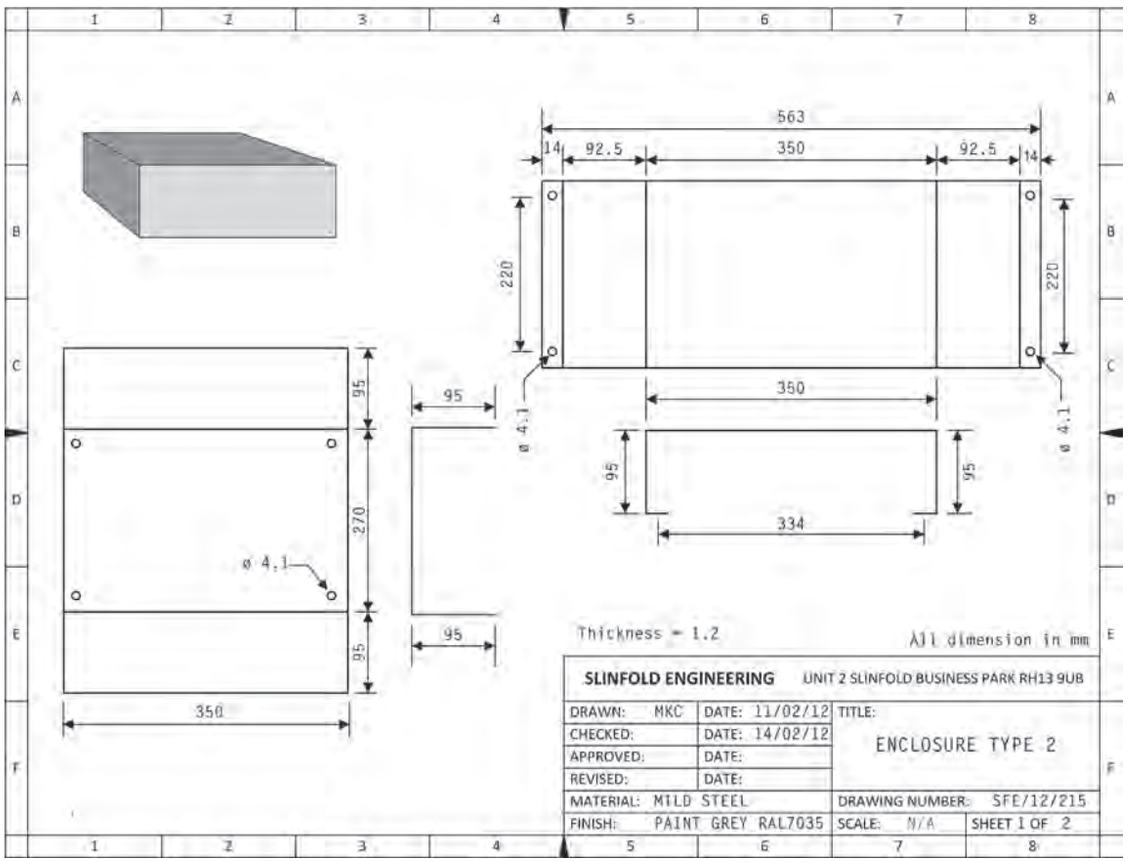

Figure 3.03 Dimensioned drawing of the metal equipment case

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Hands On

Take a careful look at the drawing shown in Figure 3.03 and use it to answer the following questions.

1. What is the reference number of the drawing?
2. On what date was the drawing made?
3. What material is used and what is its thickness?
4. What finish is to be applied to the equipment case?
5. What are the overall dimensions (before folding) of the cover and base section of the case?

Written documentation

Written information is a very important part of communicating in engineering and it can take a variety of different forms.

Data sheets and data books

Data sheets give essential information on a particular engineering component or device. They usually provide maximum and minimum values, specifications, and information on dimensions, packaging and finish.

Data sheets are usually supplied free of charge on request from manufacturers and suppliers. Collections of data sheets for similar types of engineering components and devices are sometimes also supplied in book form.

SLINFOLD ENGINEERING HTA2415 DATASHEET

The HTA series of high performance miniature DC motors are fitted with planetary gears offering outstanding torque to weight ratio and available with six different gear ratios to suit your own particular application.

Applications: Medical electronics, robotics, miniature drives and pumps

Voltage (V)	Current (A)	Stalled current (A)	Motor speed (RPM)	Weight (kg)
12	0.15	0.35	3000	0.06

Model no.	Gear ratio	No load speed (RPM)	Rated speed (RPM)	Rated torque (Nm)	Peak torque (Nm)
2415-1	50	58	48	0.09	0.82
2415-2	100	30	24	0.18	0.86
2415-3	190	15	12	0.32	0.90
2415-4	256	10	9.0	0.42	0.95
2415-5	520	5.8	4.5	0.50	1.10
2415-6	720	4.1	3.9	0.51	1.25

Figure 3.04 A data sheet for a small d.c. motor

Hands On

Figure 3.04 shows a data sheet for a miniature **d.c.** motor. Read the data sheet carefully and use it to answer the following questions.

1. What is the part number of the motor?
2. What is the name of the company that manufactures the motor?
3. What is (a) the operating voltage and (b) the operating current for the motor?
4. What is the rated speed for a motor with a model number of 2415-4?
5. What is the rated torque for a motor with a model number of 2415-2?
6. Which of the motors delivers the highest value of peak torque?

Key term

d.c. – direct current (a current that only flows in one direction)

M03_PEO_SB1_5088_M03.indd 53 27/07/2012 12:48

Application notes

Application notes explain how something is used in a particular application or how it can solve a particular problem. They provide a lot of practical information for designers and others who may be considering using a particular component, process or technology for the first time.

Technical reports

Technical reports are similar to application notes but they focus more on how engineering components and devices perform. They will usually provide detailed specifications and measurements and also describe how the measurements were obtained. Technical reports are often illustrated with graphs, charts, tables and other data.

Catalogues

Most manufacturers and suppliers provide catalogues that list the range of products they supply. These usually include part numbers, illustrations, brief specifications and prices.

While catalogues are often very large documents with many hundreds or thousands of pages, short-form catalogues are usually also available. These just list part numbers, brief descriptions and prices but rarely include any illustrations. Catalogues and data sheets are often stored in electronic form to be downloaded from the Internet or distributed on CD-ROM.

Manuals

Several different types of manual are used in engineering. The two most important types are:

- user or operating manuals – designed to be read by the end user of the product or equipment
- service, repair or maintenance manuals – designed to assist the repair and/or the routine maintenance of a product.

Manuals are usually produced by the company that has manufactured the product but may also be produced by third-party companies that specialise in manual production. Manuals are often supplied as booklets or leaflets but increasingly are being made available as **PDF** files available for download or are supplied on CD-ROM.

Key term

PDF – a Portable Document File that can be read on a wide range of electronic devices including desktops and laptops, tablets and book readers

M03_PEO_SB1_5088_M03.indd 54 27/07/2012 12:48

Job cards and work instructions

Job cards and work instructions are discussed in Chapter 2. Job cards provide information about parts and equipment and what should be done with them. They usually list the work that needs to be done and may also include the time given to each task or sub-task.

Job cards are often used when equipment is sent away for service or repair. They might also relate to a particular stage in the manufacture of a product. See page 33 for an example of a job card.

Work instructions usually contain much more detail than job cards and often describe each of the individual stages of performing a particular task or sub-task. See page 34 for an example of a work instruction.

QUICK CHECK

1. What would you expect to find in an application note?
2. What is the difference between a data sheet and an application note?
3. What would you use a job card for and what information would you expect to find in it?
4. What would you use a work instruction for and what information would you expect to find in it?

Hands On

Investigate the operating manual for an item of electronic equipment such as a multimeter, power supply or oscilloscope. List each of the main section headings and describe the information you find in it. Suggest how the manual could be improved to make it more useful. Discuss your findings with the rest of the class.

Specifications

Specifications are a precise and comprehensive description of an engineered part, product or service. Specifications should relate to the performance of the product in a way that can be measured. They also relate to what the product is going to look like.

In many cases, specifications form the basis of a contract between a manufacturer or supplier and a client or customer. For example, what the purchaser requires and what the manufacturer is going to supply. There are three basic types of specification:

- **General specifications** – a detailed written description of the product including its appearance, construction, and materials used.
- **Performance specification** – a list of features of the product that contribute to its ability to meet the needs of the client or end user. For example, output voltage, power or speed.
- **Standard specification** – a description of the materials and processes (where appropriate) used in the manufacture of the product in terms of relevant **quality** standards (e.g. ISO 9000).

Key term

Quality – when a product or service is 'free from defect' and will operate according to specification. It fully meets the needs and expectations of clients or users

M03_PEO_SB1_5088_M03.indd 55 27/07/2012 12:48

Figure 3.05 A typical cordless drill

A typical performance specification for a cordless drill might be:

Voltage:	18 V
Battery pack:	1.3 Ah Lithium ion
Speed:	1300 rpm (max)
Number of speed settings:	2
Max. rpm	1300
Number of clutch settings:	15
Chuck capacity:	12 mm
Weight:	2.5 kg
Charging time:	45 minutes

Hands On

Look at the performance specification for the cordless power drill and use it to answer the following questions.

1. What type of battery is fitted to the drill and how long does it take to recharge?
2. What is the maximum size of drill bit that can be used with the drill?
3. What units are used to specify the speed of the drill?

Hands On

Obtain detailed specifications for any two of the following engineered products:

1. an electrical test meter
2. a battery charger
3. an angle grinder
4. a mains-operated hammer drill.

For both of your chosen products determine the:

- power supply/energy source
- battery life (where appropriate)
- speed ratings (where appropriate)
- controls and settings
- compliance with relevant standards.

Drawings and diagrams

Engineers use many different kinds of diagram and drawing as a way of communicating because they can:

- often show what needs to be done more easily than words
- contain extra information including dimensions and materials
- provide different views of a component, sub-assembly or a complete product
- show how component parts fit together to make a complete assembly.

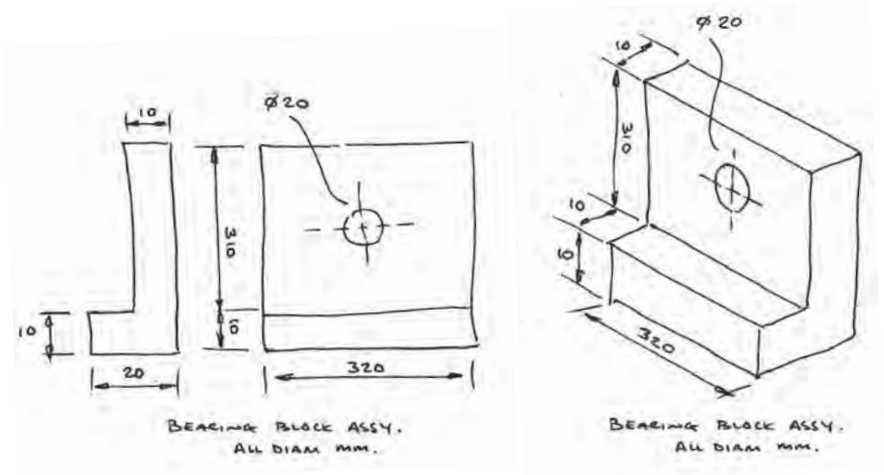
As an engineer you must be able to read and use working drawings as well as producing your own sketches and diagrams. So that everyone can understand them, your drawings must comply with recommended standards, conventions and **projections**.

Key term

Projection – a way of drawing a 3D object by viewing it from different directions

M03_PEO_SB1_5088_M03.indd 56 27/07/2012 12:48

Drawings can be either formal or informal depending on the way they are presented. Informal drawings are usually sketches or hand-drawn diagrams that provide a quick impression of what something will look like or how something will work (see Figure 3.06). Formal drawings, like the one in Figure 3.07 on page 58, take much longer to produce and usually contain much more detail. They are also much more precise and usually include features such as a scale, dimensions, materials, finishes and a title block.



(a) 2D sketch

(b) 3D sketch

Figure 3.06 A sketch of an engineering component

Sketches

Sketches are freehand drawings that give a quick impression of what something will look like. A sketch can be either a two-dimensional (2D) representation or a three-dimensional (3D) representation (see Figure 3.06). A sketch can also be used to draw a block diagram or a schematic diagram (see pages 64–65). Additional information, such as labels and dimensions, can be added to sketches. When you draw a sketch you need to ensure that it:

- is clear and easy to read
- is of a suitable size – otherwise it might be difficult for others to read
- uses the correct symbols and drawing conventions
- is in proportion to the real part or component.

If you don't follow this guidance, your sketch will be difficult to read and may even put across the wrong information!

Quick Tip

When making a sketch, it is always best to use an HB pencil and an eraser rather than a ballpoint pen. This makes it possible to easily remove any unwanted or incorrect lines. When complete you can always go over your pencil sketch using a permanent ink drawing pen.

QUICK CHECK

1. What is a drawing projection and why do you need to show several different projections of the same object?
2. List four things that you need to take into account when sketching a part or component.

M03_PEO_SB1_5088_M03.indd 57 27/07/2012 12:48

Hands On

Produce simple 3D sketches of any *two* of the following:

- a Vee block
- a pair of dividers
- a torch or inspection lamp
- a standard 13 A three-pin mains plug.

Label your sketch clearly, showing the individual parts and adding approximate dimensions.

Formal engineering drawings

Formal engineering drawings provide more information than sketches and they are usually produced using a computer-aided design (CAD) package. Most companies use a common template for all of their formal drawings. This has a border so that individual areas of the drawing can be identified. It also has a title block that shows key information like the one below.

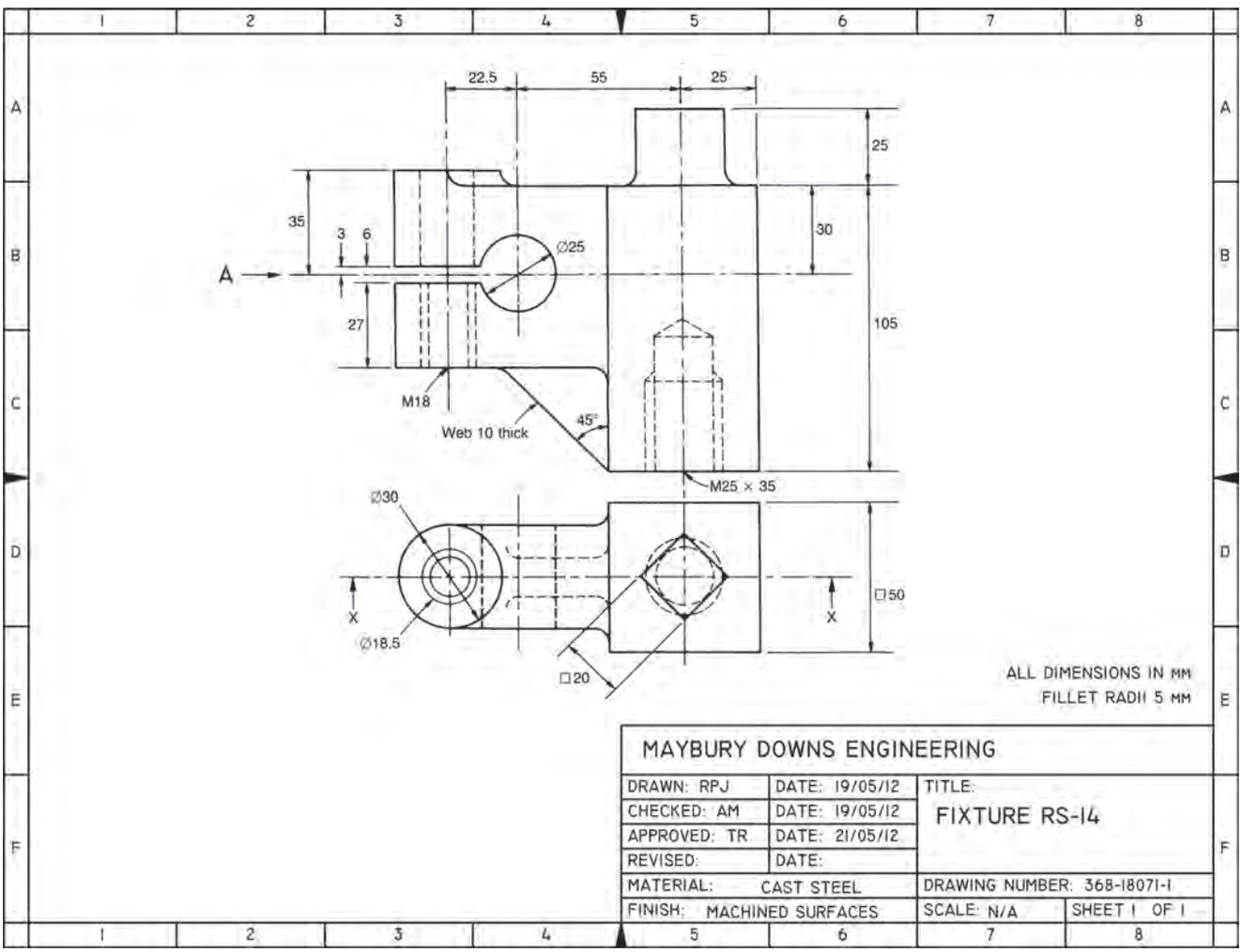


Figure 3.07 A formal engineering drawing

M03_PEO_SB1_5088_M03.indd 58 27/07/2012 12:48

Title blocks

The title block (shown in the bottom right-hand corner of Figure 3.07) contains a great deal of important information, such as the name of the company, the title of the drawing, and the names of those responsible for making, checking and approving it. It usually includes the company's contact details and the drawing number (sometimes repeated in the top left-hand corner of the drawing). You may also find the scale or dimensions used for the drawing and the projection used (e.g. first or third angle). Take a look at the examples given in Figures 3.07 to 3.09 to see what other information normally appears in a title block.

Parts lists

As well as the title block you may find a list of component parts (together with numbered references shown on the drawing) and materials to be used. You might also find information such as:

- the finish to be applied
- the units used for measurement and tolerances
- reference to appropriate standards (e.g. BS 8888)
- guidance notes (such as 'do not scale').

Drawing scales

Different drawing scales are used depending on the actual size of the part or component shown in the drawing. Scale is normally given as a ratio of the size on the drawing to the size in real life. Hence, 'full size' corresponds to a scale of 1:1. 'Reduced scale' is when the drawing is reduced, for example to 'half size'. This is when one unit on the drawing represents two units in real life and is written as 1:2. Similarly, 'quarter size' is 1:4 (one unit on the drawing is equivalent to four units in real life). Enlarged scales are also used. So, for example, 2:1 is where two units on the drawing represent one unit in real life. A scale of 5:1 is where five drawing units represent one unit in real life.

General arrangement drawings

General arrangement (GA) drawings show how the various parts used in an assembly are related to one another (see Figure 3.08). The individual parts are often listed in a table together with the quantities required. Each of these parts is drawn with more detail separately in what is referred to as a **detail drawing**.

The numbers of these drawings are usually quoted in the parts list shown in the GA drawing for the particular assembly the parts are used in. Therefore, one GA drawing is usually accompanied by a number of detail drawings. Note that individual parts (such as nuts, screws and washers) may be readily available from other suppliers while other more specialised parts may need to be manufactured especially.

M03_PEO_SB1_5088_M03.indd 59 27/07/2012 12:48

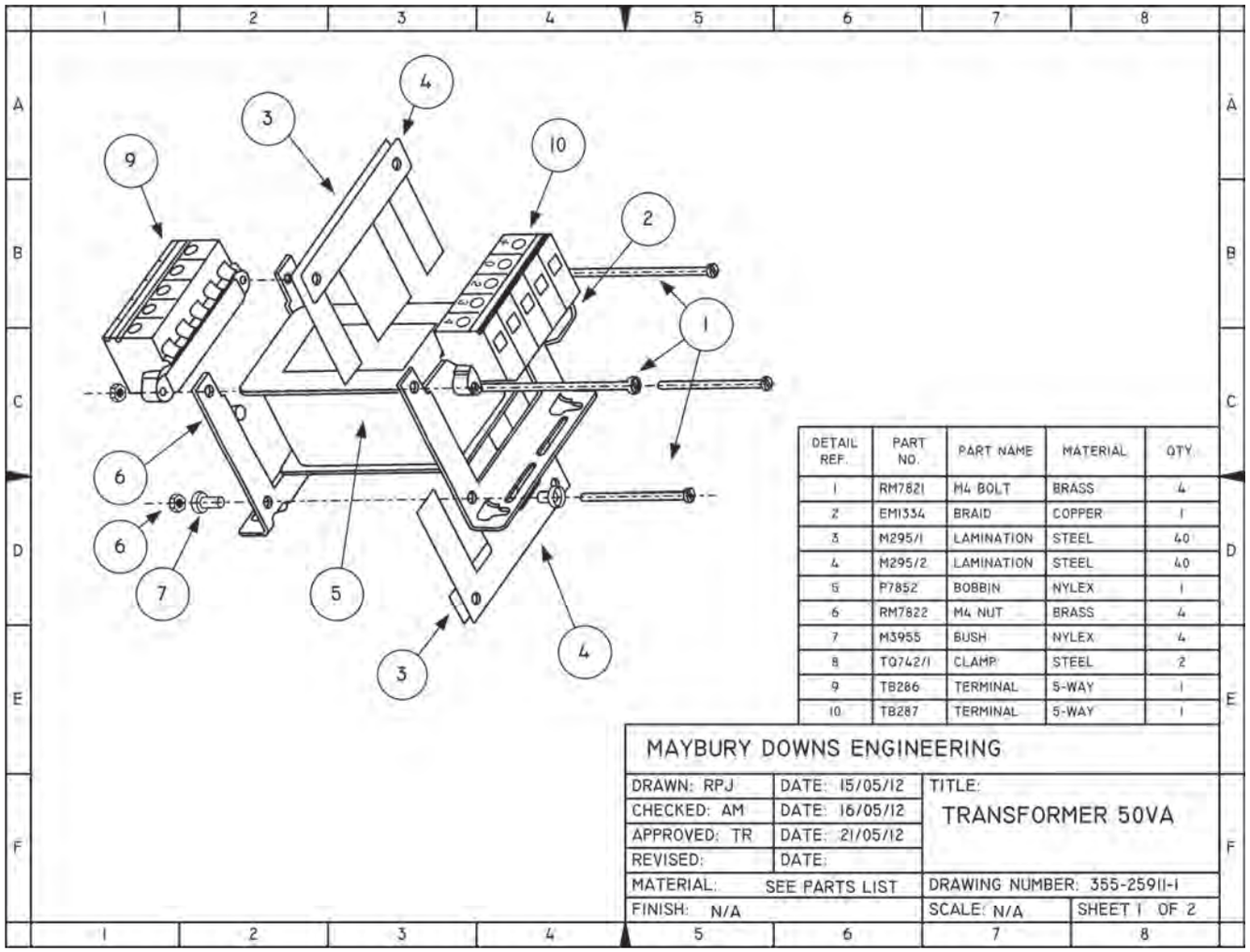

1 2 3 4 5 6 7 8
A B C D E F
4
3
9
10
2
1
6
6
7
5
3
4
DETAIL REF. | PART NO. | PART NAME | MATERIAL | QTY
1 | RM7821 | M4 BOLT | BRASS | 4
2 | EM1334 | BRAID | COPPER | 1
3 | M295/1 | LAMINATION | STEEL | 40
4 | M295/2 | LAMINATION | STEEL | 40
5 | P7852 | BOBBIN | NYLEX | 1
6 | RM7822 | M4 NUT | BRASS | 4
7 | M3955 | BUSH | NYLEX | 4
8 | TQ742/1 | CLAMP | STEEL | 2
9 | TB286 | TERMINAL | 5-WAY | 1
10 | TB287 | TERMINAL | 5-WAY | 1
MAYBURY DOWNS ENGINEERING
DRAWN: RPJ DATE: 15/05/12
CHECKED: AM DATE: 16/05/12
APPROVED: TR DATE: 21/05/12
REVISED: DATE:
MATERIAL: SEE PARTS LIST
FINISH: N/A
TITLE: TRANSFORMER 50VA
DRAWING NUMBER: 355-25911-1
SCALE: N/A
SHEET 1 OF 2

Figure 3.08 A typical GA drawing

Detail drawings

Detail drawings, like the one shown in Figure 3.09, need to provide all of the information required to make a particular part or component. Detail drawings usually include dimensions and tolerances as well as details of any finishes that need to be applied. The amount of information given in a detail drawing depends very much on the complexity of the job. For example, drawings for a critical aircraft component need to be much more detailed than those for a garden tool.

Dimensions

When dimensions are included in a drawing or sketch they should be noted clearly and neatly to avoid confusion or misinterpretation (see Figure 3.10). When adding dimensions, you need to:

- closely follow the conventions associated with dimensioning
- make sure they can't be confused with the original drawing lines and annotation
- use a common fixed reference point.

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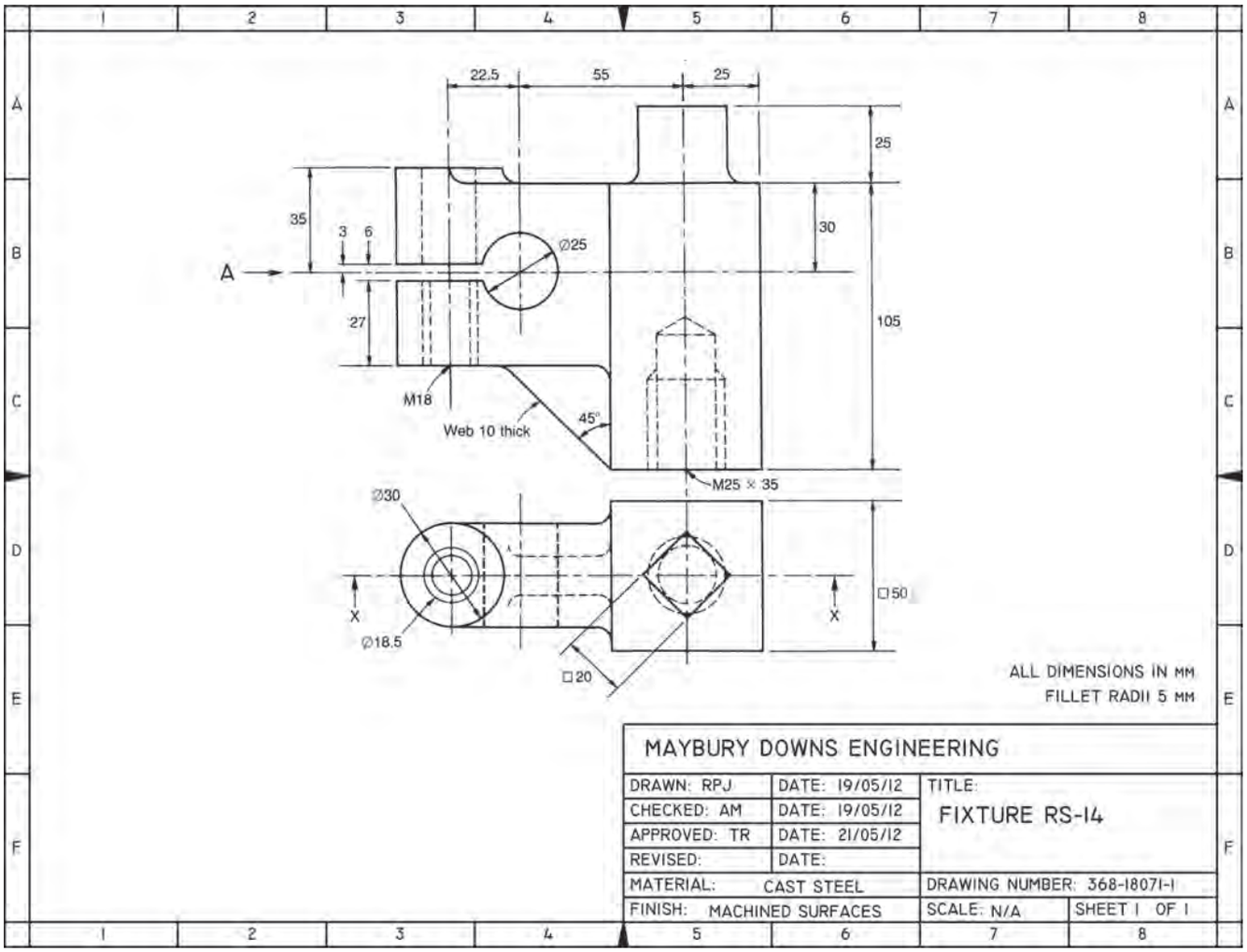

Figure 3.09 A typical detail drawing

QUICK CHECK

1. What is the difference between (a) a reduced scale and (b) an enlarged scale on an engineering drawing? Give an example of each.
2. What is the difference between a GA drawing and a detail drawing? How are these two types of drawing related?
3. What information would you expect to find in the title block of a formal drawing? Explain why this information is important.

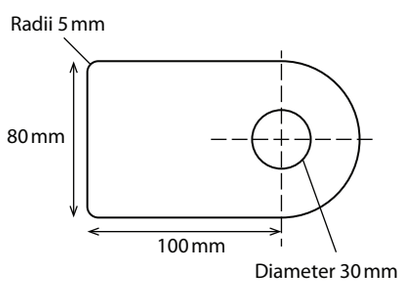

Figure 3.10 A dimensioned detail drawing of a part

Hands On

1. Make a copy of the detail drawing shown in Figure 3.10 using an HB pencil, ruler, square, compasses and an A4 drawing sheet. Don't forget to include a title block.
2. There are two errors in Figure 3.10. Find the two errors and correct them on your drawing.

M03_PEO_SB1_5088_M03.indd 61 27/07/2012 12:48

Drawing types and projections

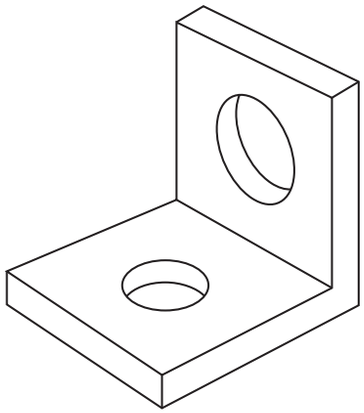

Figure 3.11 An isometric drawing

As you will have noticed from the sketching you did earlier, it's fairly easy to draw an object in 2D but not quite so easy to produce a 3D view using only a 2D screen or sheet of drawing paper. Modern 3D CAD overcomes this problem and allows engineers to view a part or component from any angle. Despite this, engineers still need to be able to draw a solid object well, using only a pencil and a drawing sheet.

Isometric drawings

Isometric drawings allow you to show 3D objects in a 2D drawing. It does this by drawing vertical lines conventionally and all other lines at an angle of 30° to the horizontal, as shown in Figure 3.11. Lines are normally drawn using their correct (or correctly scaled) length. Modern CAD systems make this easy by helping to snap lines to an isometric grid and also by drawing ellipses to represent circles.

When you need to show an object in more detail, using a series of views from different directions can be helpful. Two methods are commonly used: first angle (or 'English') projection and third angle (or 'American') projection.

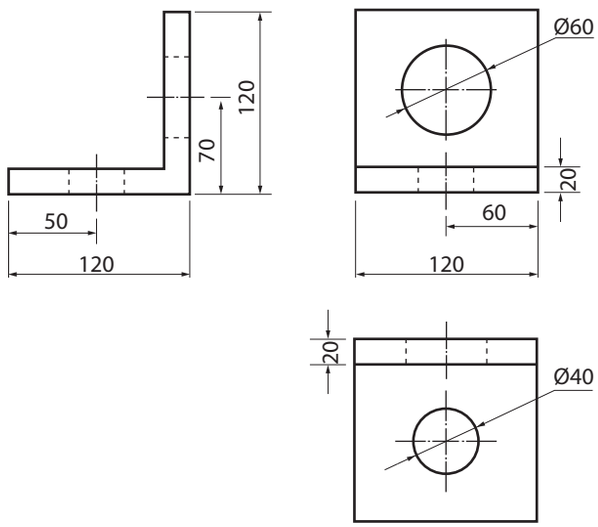

Figure 3.12 First angle projection

First angle projection

To be able to show all of the detail of an object, more than one view is necessary. In most cases three different views (or 'projections') are required. These three views are called front elevation, end elevation and plan view.

In first angle projection, first you draw a front view of the object. Then, by looking from one side of the object, you draw what you would see on the other side. Figure 3.12 shows how this is done.

The two elevations and the plan view are drawn as follows.

- **Front elevation** – to draw this, you look directly at the front of the part and draw what you see. This is the main view from which all the other views are positioned.
- **End elevation** – to draw this, you look directly at the side of the part and draw what you see *at the opposite side*. Note that, for some parts you might need two end views, one at each side of the elevation.
- **Plan view** – to draw this, you look directly down on the part and draw what you see below the elevation.

Figure 3.12 requires only one end view. When there is only one end view, choose the end that is clearer and more easily interpreted.

Hands On

Use manual drawing techniques to create a first angle drawing of a simple engineering part such as a flange or bracket. Make sure that you correctly show all three views of the part.

M03_PEO_SB1_5088_M03.indd 62 27/07/2012 12:48

Third angle projection

In the case of third angle projection the drawing once again starts with a front view of the object. This time, however, you look at one side of the object and draw what you would see on the *same* side. Next you look at the object from above and draw what you would see from above (*not* from underneath as was the case with first angle projection).

Figure 3.13 shows how this appears. It shows a simple part and this only requires one end view.

Here is how the three individual views are produced.

- **Front elevation** – to draw this, you look directly at the front of the part and draw what you see. This is the main view from which all the other views are positioned.
- **End elevation** – to draw this, you look directly at the side of the part and again draw what you see. As before, it is worth noting that, for some parts you may need two end views, one at each end of the elevation.
- **Plan** – to draw this, you look directly down on the part and draw what you see below the elevation.

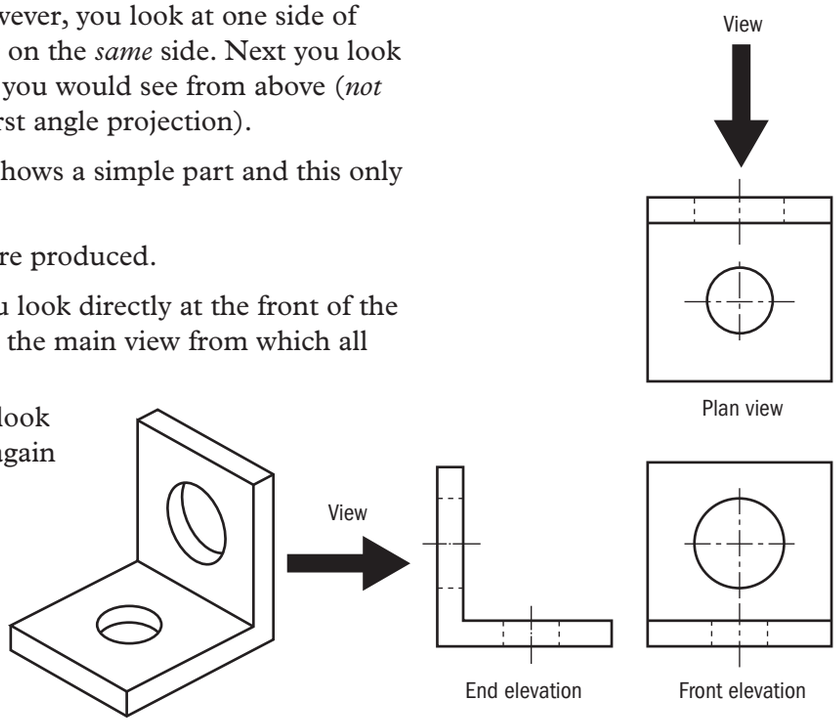

Figure 3.13 Third angle projection

Hands On

Find at least two examples of isometric drawings (used in your company or supplied by your tutor). For each drawing identify the front elevation, end elevation and plan view, and say whether first or third angle projection has been used. Hint: Look for the symbol on the drawing!

Auxiliary views

In addition to the main views shown on a drawing sheet, it is sometimes necessary to use additional (or 'auxiliary') views in order to clarify the drawing and reduce ambiguity. Auxiliary views are used when you can't show the true outline of the component. They are also used when you wish to illustrate a particular feature of the component.

QUICK CHECK

1 What is an isometric drawing and how is it constructed?
2 What is the difference between first angle and third angle projection?

M03_PEO_SB1_5088_M03.indd 63 27/07/2012 12:48

Other diagrams

As well as sketches, GA and detail drawings, engineers use several other types of diagram including block diagrams, flow diagrams, schematics and exploded views. All of these provide useful information for engineers.

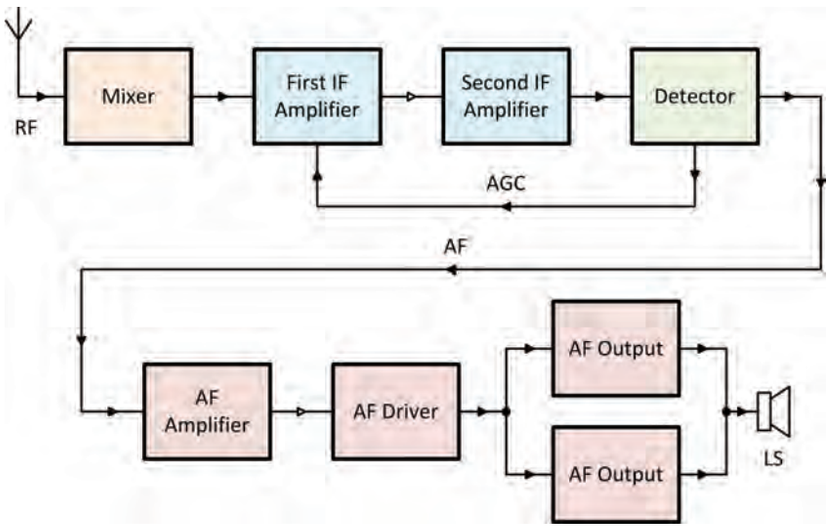

Figure 3.14 A block schematic diagram for a radio receiver

Block diagrams

Block diagrams are useful for showing how individual parts are connected or linked together. They are not intended to show the physical relationship between the parts but instead they show how the parts are connected together. Block diagrams use shapes – often square or rectangular boxes connected together with arrows to show the flow of signals, power, fluid or information. Figure 3.14 shows the block diagram of a radio receiver. Diagrams like this can be very useful when carrying out fault finding.

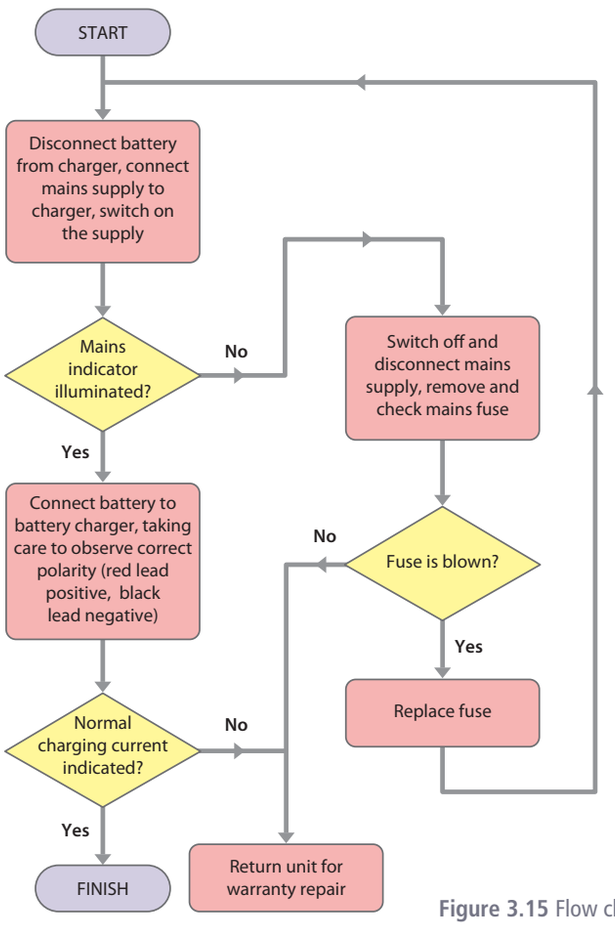
START
Disconnect battery from charger, connect mains supply to charger, switch on the supply
Mains indicator illuminated?
No
Switch off and disconnect mains supply, remove and check mains fuse
Yes
Connect battery to battery charger, taking care to observe correct polarity (red lead positive, black lead negative)
No
Fuse is blown?
Yes
Replace fuse
Normal charging current indicated?
No
Yes
FINISH
Return unit for warranty repair

Figure 3.15 Flow chart for fault finding on a battery charger

Flow diagrams

Flow diagrams or flow charts are used to illustrate a sequence of events. They are often used to describe engineering processes such as the stages involved in the manufacture of a product or the maintenance of a piece of equipment (see Figure 3.15).

Schematic diagrams

Schematic diagrams are used to show how components are connected together in electrical, pneumatic and hydraulic circuits. Schematic diagrams use standard symbols and the links between them are shown with lines. There are several types of schematic diagram including:

- **Circuit diagrams** – used to show how components are connected in an electric or electronic circuit. The components are represented by symbols (see Figure 3.16) and the electrical connections between the components are drawn using straight lines.
- **Wiring diagrams** – used to show the physical connections between electrical and electronic components (i.e. the actual layout of the wires).

M03_PEO_SB1_5088_M03.indd 64 27/07/2012 12:48

- **Pneumatic and hydraulic diagrams** – represent pneumatic circuits and hydraulic circuits using standard symbols.
- **Piping diagrams** – used to show the physical connections between pneumatic and hydraulic components (i.e. the actual layout of the pipes).

More details about the components and symbols used in electronic circuits can be found in Chapter 7. An example of a complete electronic circuit is shown in Figure 3.16. Figure 3.17 shows a hydraulic circuit.

Key terms

Pneumatic – a system that uses compressed gas (usually air) to produce motion

Hydraulic – a system that uses compressed liquid (usually special oil-based hydraulic fluid) to produce motion

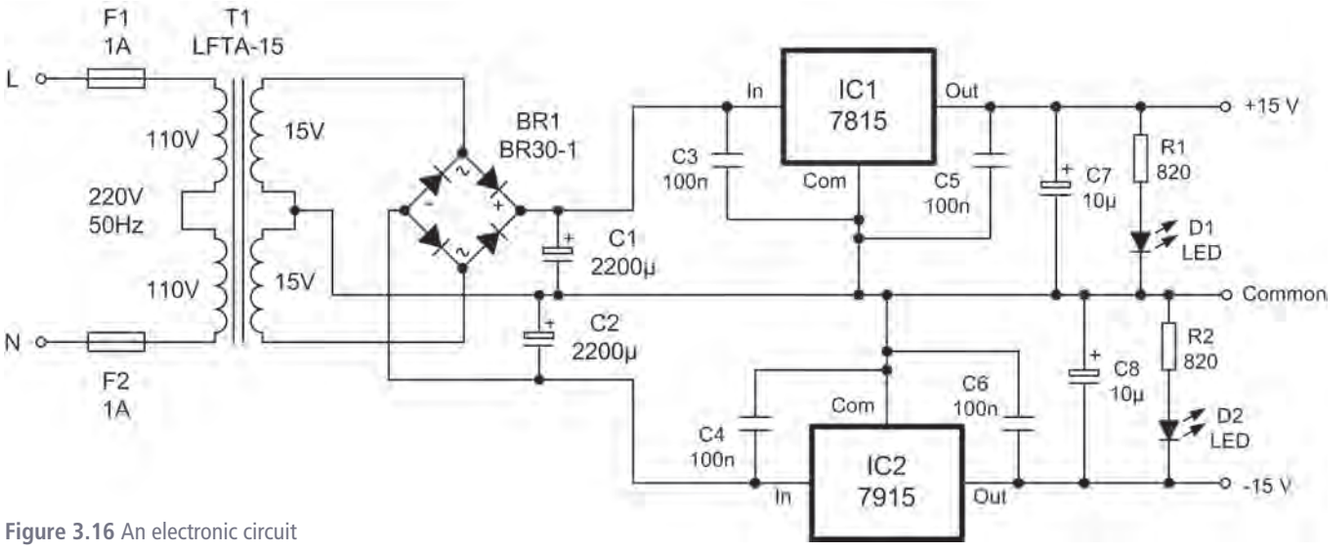

Figure 3.16 An electronic circuit

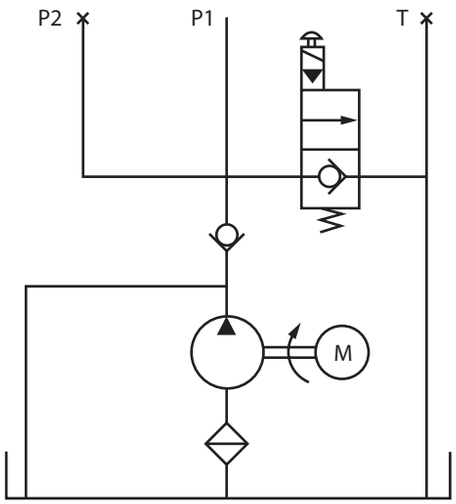

Figure 3.17 A hydraulic circuit

Quick Tip

It is worth remembering that the position of a component in a schematic diagram may not bear any relationship to its actual physical position. This is particularly true for circuit diagrams where a wiring diagram often looks very different from the corresponding circuit diagram.

Did You Know

Pneumatic circuits and hydraulic circuits share the same symbols. You can tell which circuit is which because pneumatic circuits should have open arrowheads, whereas hydraulic circuits should have solid arrowheads. Also, pneumatic circuits exhaust to the atmosphere, but hydraulic circuits have to have a return path to a fluid reservoir.

Exploded views

Exploded views are similar to GA diagrams. The key difference is that GA diagrams show how the parts fit together when a product is manufactured and exploded views show how they can be taken apart and reassembled.

M03_PEO_SB1_5088_M03.indd 65 27/07/2012 12:48

Exploded views can be extremely useful when a product has to be serviced or maintained. A service or maintenance engineer has only to take a look at an exploded diagram to see how the various parts fit together. A typical assembly diagram for an electrical control box is shown in Figure 3.18.

A = Enclosure base with built in contact block clips
B = Contact blocks/lamp holders
C = Locking ring
D = Enclosure lid
E = Legend plate
F = Captive screws (after screw-in) loose in enclosure on delivery
G = Actuators and lens cap

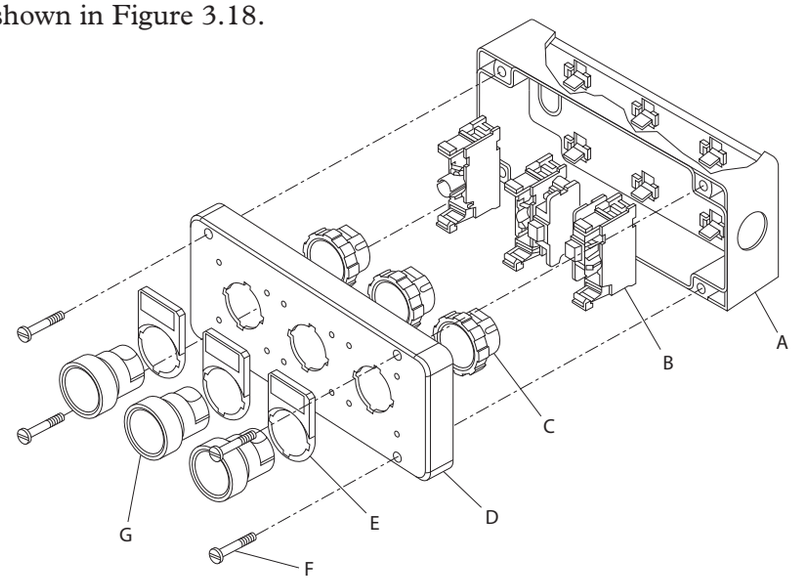

Figure 3.18 An exploded view of an electrical control box with key

Charts, graphs and tables

Charts, graphs and tables are used to present data in a way that makes it easy to use and understand. Charts and graphs provide a simple way of showing data as a picture. Tables are ideal for presenting numerical data, such as the different screw threads and clearances.

Metric size	Nominal diameter (d)	Coarse pitch (p)	Bolt head		
			Height (H)	Flat size (A/F)	Ext. diam (A/C)
M3	3.00 mm	0.50 mm	2.125 mm	5.5 mm	6.4 mm
M4	4.00 mm	0.70 mm	2.925 mm	7.0 mm	8.1 mm
M5	5.00 mm	0.80 mm	3.65 mm	8.0 mm	9.2 mm
M6	6.00 mm	1.00 mm	4.15 mm	10.0 mm	11.5 mm
M8	8.00 mm	1.25 mm	5.65 mm	13.0 mm	15.0 mm
M10	10.00 mm	1.50 mm	7.18 mm	17.0 mm	19.6 mm

Table 3.01 Metric screw threads

QUICK CHECK

1. What is the difference between a block diagram and a flow chart? Give an example of what you would use each type of diagram for.
2. Sketch four different symbols used in electronic circuits and name each of the components.
3. What is an exploded view used for? What does it help you to do?
4. Give an example of the use of (a) charts and (b) tables to present engineering data.

M03_PEO_SB1_5088_M03.indd 66 27/07/2012 12:48

Care and control of documents/drawings

Engineering documents and drawings are important so they need to be used and stored correctly. This will ensure that they are not damaged as a result of physical handling or the environment they are used in. Documents must be stored in appropriate cabinets well away from dust, dirt, oil and grease. It is vital to have a system that controls the taking and returning of documents, particularly where a number of people must have access to them. Damaged or lost drawings should always be reported to your supervisor or another responsible person.

Engineering documents/drawings should always be marked with the:

- originator's name
- issue number and/or the date of issue
- date of any subsequent revisions or modifications.

Most companies store drawings and documents electronically. This makes them widely accessible within the company and also makes it easy to update them whenever the need arises.

Key term

Controlled document – a reference document which, through the course of its lifecycle, may be reviewed, modified and reissued several times

Controlled documents

Document control is used in all large engineering companies and the use of computerised systems has made this much easier and more effective. If a controlled document is changed, a record of the change has to be made. Equally importantly, employees should always remember to check they are using the current version of a controlled document.

When a controlled document is changed, everyone who needs it should be made aware and should also make sure they have access to the current version. This means that versions of a document, as well as any revisions made to it, need to be clearly identified.

Hands On

Find an example of a controlled document used in your company and use it to answer the following questions:

1. What is the title and purpose of the document?
2. What is the name of the person who authorised the document?
3. What is the date of the document?
4. Have any changes been made to the document and how do you know?

Dealing with problems

You will need to deal promptly and effectively with any problems that arise at work and are within your control. Some problems can be solved quite easily by yourself but others may require you to seek help and guidance from other people. Most engineering companies have regular team meetings and these can provide a useful forum for discussing problems and sharing ideas that can lead to a solution. More urgent problems may need to be resolved at the time they crop up. You will normally refer these to your supervisor or team leader.

Quick Tip

Team meetings provide you with an opportunity to ask questions and make a contribution to your work and team. It's always worth keeping a few written notes to act as a reminder of what was discussed and agreed.

Hands On

Describe the procedures for (a) reporting discrepancies in data or documents and (b) for reporting lost or damaged documents within your company.

Describe the care and control procedures for documents in your company including (a) reporting errors and changes, and (b) dealing with damaged or lost documents.

M03_PEO_SB1_5088_M03.indd 67 27/07/2012 12:48

CHECK YOUR KNOWLEDGE

1 Which one of the following appears in the title block of a drawing?

- **a** a comprehensive parts list
- **b** the dimensions of each component
- **c** the company name and contact information
- **d** isometric or orthographic views, as appropriate

2 A precision part is manufactured:

- **a** to a high degree of accuracy
- **b** without dimensioned drawings
- **c** using sketches with approximate dimensions
- **d** using only drawings made to a strict 1:1 scale

3 If a diagram is drawn half size, it means that:

- **a** the scale is 2:1
- **b** only half the drawing area is actually used
- **c** one unit on the drawing represents two units in the real world
- **d** two drawings sheets are needed to represent the part or component

4 The reference numbers for the individual components used in an assembly are usually found in:

- **a** a parts list
- **b** a specification
- **c** a technical report
- **d** an application note

5 Formal engineering drawings are normally produced using:

- **a** a CAD package
- **b** a series of sketches
- **c** a single sketch supplemented by a parts list
- **d** word processing software

6 Which one of the following is a schematic drawing?

- **a** a bar chart
- **b** a circuit diagram
- **c** an isometric view
- **d** a general arrangement (GA) diagram

7 Changes made to update a drawing are usually found in the:

- **a** parts list
- **b** revision list
- **c** isometric view
- **d** supporting documentation

8 A flow chart shows:

- **a** how several parts fit together
- **b** an exploded view of a product
- **c** a sequence of events or processes
- **d** the detail of an individual part or component

9 A summary of the features of a particular part or component can be found in:

- **a** a data sheet
- **b** a technical report
- **c** a service manual
- **d** an operating manual

10 The plan view of a part is obtained by looking:

- **a** at the front of the component and drawing what you see
- **b** from the side and drawing what you see on the opposite side
- **c** from the rear and drawing what you see on the opposite side
- **d** down at the component from above and drawing what you see

M03_PEO_SB1_5088_M03.indd 68 27/07/2012 12:48